

Detecting a major ignimbrite event in the Central Andes

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Caldera-related ash-flow sheets may form extensive deposits as far as 100 Km from the source. Correlation of outcrops from these large ignimbrites is difficult due to causes such as (1) discontinuous initial distribution resulting from either or both eruption mechanism and/or topographic control on emplacement, (2) later discontinuity of outcrops due to burial or erosion, (3) vertical and lateral variations in characteristics such as welding, crystallization, mean grain-size, sorting, and chemical zonation (see discussion in Hildreth and Mahood, 1985). The relatively fast (respect to eruptive frequency) shift of the geomagnetic field makes the accurate definition of the primary magnetization vector be a temporal fingerprint for a particular unit, thus facilitating the identification and correlation of isolated ignimbrite outcrops; which in turn helps to reconstruct the extent of the former ash-flow sheet.

To illustrate this, we present a case study of correlation in the late Miocene ignimbrite province of the Central Andes. After several sampling sessions for tectonic studies we observed that dispersed outcrops from previously unrelated upper Miocene ignimbrite units in northern Chile, northwestern Argentina, and southwestern Bolivia carry a north-directed downward magnetization that is deviated about 60° from the time-averaged late Miocene geomagnetic field (Fig. 1). This remanence is likely related to either an excursion or a transition of the paleofield, constituting a powerful fingerprint to identify coeval outcrops throughout the region. Formally, the units carrying it are recognized as the Sifón Ignimbrite in northern Chile (paleomagnetic data listed in Somoza et al., 1999 and Arriagada et al., 2003), the Vilama Ignimbrite in northwest Argentina (most paleomagnetic data listed in Somoza et al., 1996), and different units in SW Bolivia (Tobas Loromayu, Tobas Lagunillas, y Toba Lupi Gera; unpublished paleomagnetic data). All these rocks are crystal rich, high K dacites showing similar phenocryst association. Various K/Ar and Ar³⁹/Ar⁴⁰ dates on biotite from outcrops in the three countries consistently yield an age of ca. 8.4 Ma. These positive correlations indicate that we are observing the products of a major volcanic event which we name the Vilama-Sifón ignimbrite. We estimated the initial ash-flow deposits covering an area of at least 20000 km² (Fig. 1). Available estimates suggest that the bulk volume of the deposits exceeds 1000 km³, ranking among the largest known explosive eruptions on Earth (see Mason et al., 2004).

De Silva and Francis (1989) proposed that the Caldera Pastos Grandes (Fig. 1) could be the source of the Sifón Ignimbrite, however dating on tuffs suggest that such caldera began to form at ca. 3.6 Ma (Espinoza and Ramírez, 1998), this is later than the occurrence of the Vilama-Sifón event. On the other hand, field observations suggest that the Caldera Vilama (Fig. 1) is the likely source of the Vilama Ignimbrite and its equivalents in SW

Bolivia (Soler et al., 2004). Anisotropy of the magnetic susceptibility results from 21 sites in all the three countries suggest that this latter interpretation could be extended for the whole of the Vilama-Sifon event.

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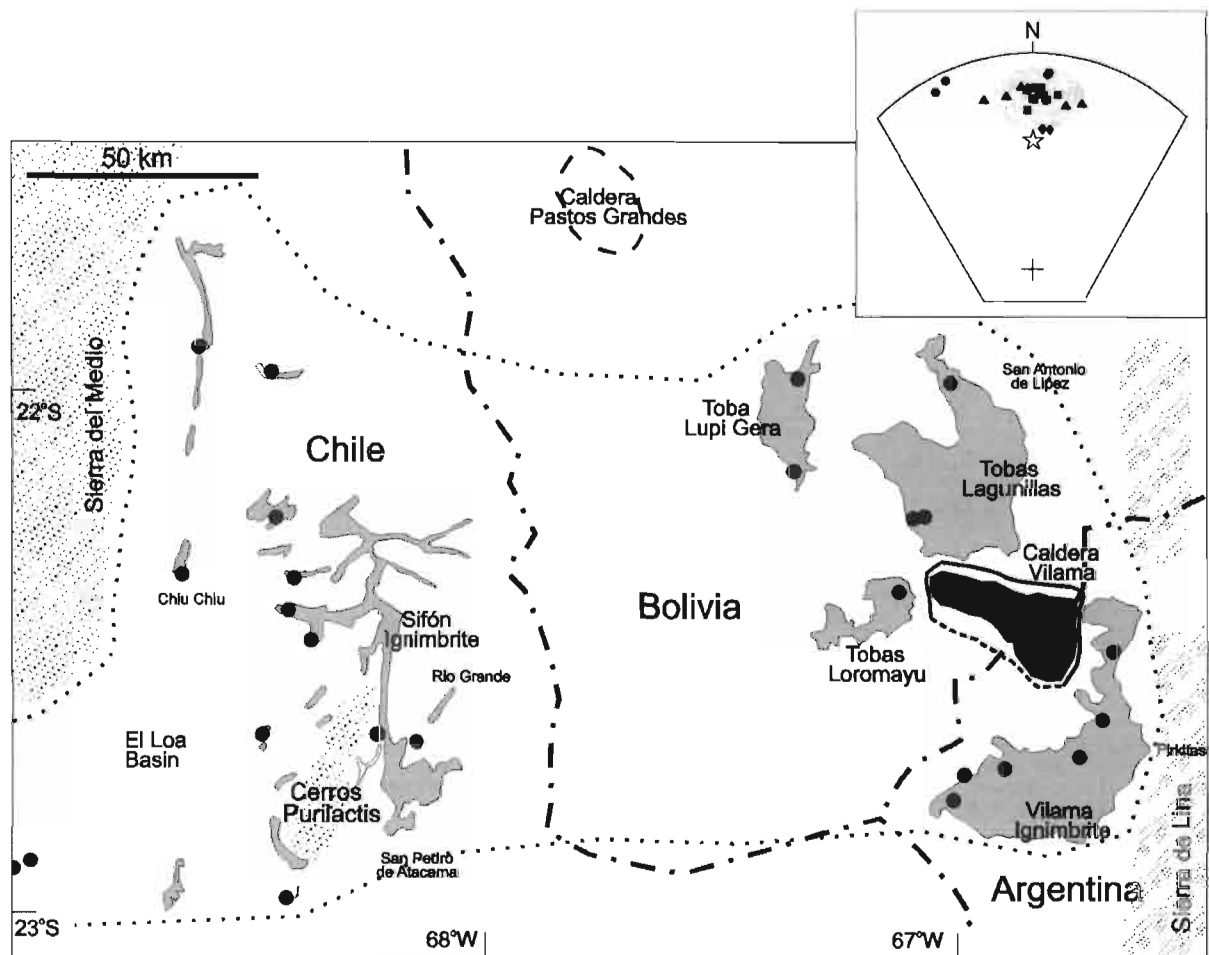


Figure 1. Outcrops of the Vilama, Sifón, and coeval ignimbrite units in Bolivia. It is assumed that further correlative rocks must be buried below younger products of the volcanic arc along the Chile-Bolivia international border. Dotted line enclosed the possible area of initial distribution of ash flow deposits. Black dots show location of paleomagnetic sites. Black symbols in the inset show site mean remanences (all of them downward in the stereonet). Grey ellipse is an arbitrary 15° cone enclosing the main cluster of vectors. White star denotes the expected direction of the late Miocene magnetic field (upward in the stereonet).